Louisiana Believes

Crosswalk for Louisiana Student Standards for Science and NGSS: Environmental Science

This document provides guidance to assist teachers, schools, and systems with determining alignment to Louisiana Student Standards for Science for resources designed for the Next Generation Science Standards. This guidance document is considered a "living" document, as we believe that teachers and other educators will find ways to improve the document as they use it. Please send feedback to STEM@la.gov so that we may use your input when updating this guide.

Updated August 25, 2021

DEPARTMENT of EDUCATION
Louisiana Believes

RESOURCES AND RESOURCE MANAGEMENT	HS-EVS1-1
***Standard HS-EVS1-1 appears in the Louisiana Student Standards for Science (LSSS) ONLY**	
Analyze and interpret data to identify the factors that affect sustainable development and natural resource management in Louisiana.	
Clarification Statement	
Evidence of Louisiana's natural resource wealth is found in understanding functions and values of varied ecosystems and environments, supply of non-renewable mining products and profitable agricultural commodities. Examples of key natural resources include state waterways (such as rivers, lakes, and bayous) and the aquatic life found in them, regions of agriculture (pine forests, sugar cane and rice fields) and high concentrations of minerals and fossil fuels on and off shore. Factors to consider in reviewing the management of natural resources include a review of historical practices, costs of resource extraction and waste management, consumption of natural resources, ongoing research and the advancements in technology.	
Science and Engineering Practice:	Analyzing and interpreting data
Disciplinary Core Ideas:	Louisiana's natural resources
Ecosystem capital can be characterized as goods (removable products) and services such as the functions and values of wetlands. (HS.EVS1A.a)	
Crosscutting Concepts:	Stability and change
Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.	

RESOURCES AND RESOURCE MANAGEMENT	HS-EVS1-2
***Standard HS-EVS1-2 appears in the Louisiana Student Standards for Science (LSSS) ONLY**	
Obtain, evaluate and communicate information on the effectiveness of management or conservation practices for one of Louisiana's natural resources with respect to common considerations such as social, economic, technological, and influencing political factors over the past 50 years.	
Clarification Statement	
The rate of land loss and habitat conversion from a variety of forces results in stresses and constraints that influence decisions and carry consequences that affect quality of life and have a bearing on sustainability. Increases in commercial and recreational uses may result in the need for environmental policies and call for changes in long established practices. Community efforts to address changes to secure growth while preserving the resources depend on education and collaboration between groups. Examples may include ground water conservation, erosion/flood control, forestry stewardship, game and wildlife, commercial fishing, oil and gas industry, dredging, or regulatory factors.	
Science and Engineering Practice:	Obtaining, evaluating and communicating information
Disciplinary Core Ideas:	Resource management for Louisiana
Population growth along with cultural and economic factors impact resource availability, distribution and use. (HS.EVS1B.a) Some changes to our natural environment such as the building of levees and hydrological modification have provided for economic and social development but have resulted in unintended negative impacts. (HS.EVS1.B.b)	
Crosscutting Concepts:	Systems and system models
When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.	

RESOURCES AND RESOURCE MANAGEMENT	HS-EVS1-3
***Standard HS-EVS1-3 appears in the Louisiana Student Standards for Science (LSSS) ONLY**	
Analyze and interpret data about the consequences of environmental decisions to determine the risk-benefit values of actions and practices implemented for selected issues.	
Clarification Statement	
Examples could be taken from system interactions: (1) loss of ground vegetation causing an increase in water runoff and soil erosion. (2) dammed rivers increasing ground-water recharge, decreasing sediment transport, and increasing coastal erosion. (3) loss of wetlands reducing storm protection buffer zones allowing further wetland reduction. (4) hydrological modification such as levees providing protection to infrastructure at a cost to ecosystems.	
Science and Engineering Practice:	Analyzing and interpreting data
Disciplinary Core Ideas:	Resource management for Louisiana
Some changes to our natural environment such as the building of levees and hydrological modification have provided for economic and social development but have resulted in unintended negative impacts. (HS.EVS1B.b)	
Crosscutting Concepts:	Cause and effect
Cause and effect relationships can be suggested and predicted for complex natural and human-designed systems by examining what is known about smaller scale mechanisms within the system.	

ENVIRONMENTAL AWARENESS AND PROTECTION	HS-EVS2-1
***Standard HS-EVS2-1 appears in the Louisiana Student Standards for Science (LSSS) ONLY**	
Design and evaluate a solution to limit the introduction of non-point source pollution into state waterways.	
Clarification Statement	
Examples of non-point source water pollution could include nitrogen and phosphorus compounds from agricultural activities and sediments from poor land-use practices. Nitrogen and phosphorus contribute to eutrophication and are anthropegenic drivers of the Gulf of Mexico hypoxic area known as the dead zone.	
Science and Engineering Practice:	Constructing explanations and designing solutions
Disciplinary Core Ideas:	Pollution and the environment
Pollution includes both natural and man-made substances which occur at rates or levels which incur harm (i.e. combustion of fossil fuels, agricultural waste, and industrial byproducts). Pollution can be categorized as point-source pollution and non-point source pollution. (HS.EVS2A.a)	
	Environmental Choices
Different approaches can be used to manage impacts to our environment. Generally speaking, we can change human activities to limit negative impacts. Alternately, we can use technologies that reduce impact or we can perform restoration work to recover natural functions and values. (HS.EVS2C.a) Trade-offs occur when we make environmental choices. (HS.EVS2C.b)	
	Defining and delimiting engineering problems
Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HS.ETS1A.b)	
Crosscutting Concepts:	Structure and function
Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.	

ENVIRONMENTAL AWARENESS AND PROTECTION	HS-EVS2-2
***Standard HS-EVS2-2 appears in the Louisiana Student Standards for Science (LSSS) ONLY**	
Use a model to predict the effects that pollution as a limiting factor has on an organism's population density.	
Clarification Statement	
The law of limiting factors is often illustrated as a graphic tolerance curve and can be used to infer the range of tolerance a species has for specific pollution hazards. When combined with real-world data such as field measurements of abiotic factors, these models can be used to help predict the suitability of an ecosystem for a particular species.	
Science and Engineering Practice:	Developing and using models
Disciplinary Core Ideas:	Pollution and the environment
Different organisms have unique tolerances to pollution hazards. Many of the organisms most tolerant of pollution are the least desirable to humans (e.g., for food, for recreation, for ecosystem services). (HS.EVS2A.b)	
Crosscutting Concepts:	Cause and effect
Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.	

ENVIRONMENTAL AWARENESS AND PROTECTION	HS-EVS2-3
***Standard HS-EVS2-3 appears in the Louisiana Student Standards for Science (LSSS) ONLY**	
Use multiple lines of evidence to construct an argument addressing the negative impacts that introduced organisms have on Louisiana's native species.	
Clarification Statement	
The exotic organisms introduced in Louisiana include plants such as Chinese tallow, kudzu and water hyacinth and animals including nutria, Asian tiger mosquitoes and zebra mussels. These organisms can have impacts on scales ranging from the level of the individual (e.g. competition) to that of the landscape (e.g. the destruction of coastal marshes by nutria).	
Science and Engineering Practice:	Engaging in argument from evidence
Disciplinary Core Ideas:	Ecosystem change
The introduction of exotic/invasive species causes a disruption in natural ecosystems and can lead to the loss of native species (i.e. threatened/endangered). (HS.EVS2B.a) Changes in ecosystems impact the availability of natural resources (e.g. sediment starvation, climate change). (HS.EVS2B.b)	
Crosscutting Concepts:	Cause and effect
Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.	

PERSONAL RESPONSIBILITIES	HS-EVS3-1
***Standard HS-EVS3-1 appears in the Louisiana Student Standards for Science (LSSS) ONLY**	
Construct and evaluate arguments about the positive and negative consequences of using disposable resources versus reusable resources.	
Clarification Statement	
Resources can be both natural or man-made and may include renewable and non-renewable energy sources, soil, ecosystems, forestry, fisheries, plastic, paper, or aluminum products. Energy used to create and dispose of products may also be considered.	
Science and Engineering Practice:	Engaging in argument from evidence
Disciplinary Core Ideas:	Stewardship
TEcosystem sustainability can be used as a model for a sustainable society (e.g. recycling, energy efficiency, diversity). (HS.EVS3A.a) Louisiana citizens are responsible for conserving our state's natural resources. Personal actions can have a positive or negative impact. (HS.EVS3A.b)	
Crosscutting Concepts:	Energy and matter
Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.	

EARTH'S SYSTEMS	HS-ESS2-2
LSSS	**NGSS**
Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth's systems.	
Clarification Statement	
Examples could include climate feedbacks such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice which reduces the amount of sunlight reflected from Earth's surface increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase ground water recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent.	
Science and Engineering Practice:	Analyzing and interpreting data
Disciplinary Core Ideas:	Earth materials and systems
Earth's systems, being dynamic and interacting, include feedback effects that can increase or decrease the original changes. (HS.ESS2A.a)	
	Weather and climate
The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, hydrosphere, and land systems, and this energy's re-radiation into space. (HS.ESS2D.a)	
Crosscutting Concepts:	Stability and change
Feedback (negative or positive) can stabilize or destabilize a system.	

EARTH'S SYSTEMS	HS-ESS2-4
LSSS	**NGSS**
Analyze and interpret data to explore how variations in the flow of energy into and out of Earth's systems result in changes in atmosphere and climate.	Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate
Clarification Statement	
Changes differ by timescale, from sudden (large volcanic eruption, hydrosphere circulation) to intermediate (hydrosphere circulation, solar output, human activity) and long-term (Earth's orbit and the orientation of its axis and changes in atmospheric composition). Examples of human activities could include fossil fuel combustion, cement production, or agricultural activity and natural processes such as changes in incoming solar radiation or volcanic activity. Examples of data can include tables, graphs, maps of global and regional temperatures, and atmospheric levels of gases.	Examples of the causes of climate change differ by timescale, over 1-10 years: large volcanic eruption, ocean circulation; 10-100s of years: changes in human activity, ocean circulation, solar output; 10-100s of thousands of years: changes to Earth's orbit and the orientation of its axis; and 10-100s of millions of years: long-term changes in atmospheric composition.
Science and Engineering Practice:	
Analyzing and interpreting data	Developing and using models
Disciplinary Core Ideas:	Earth and the solar system
Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on Earth. These phenomena cause a cycle of ice ages and other gradual climate changes. (HS.ESS1B.b)	
	Earth materials and systems
The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, hydrosphere circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS.ESS2A.d)	

Weather and climate	
The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, hydrosphere and land systems, and this energy's re-radiation into space. (HS.ESS2D.a) Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS.ESS2D.b) Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS.ESS2D.c)	The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, hydrosphere and land systems, and this energy's re-radiation into space. (HS.ESS2D.a)
Crosscutting Concepts:	Cause and effect
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	

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EARTH'S SYSTEMS	HS-ESS2-5
LSSS	**NGSS**
Plan and conduct an investigation on the properties of water and its effects on Earth materials and surface processes.	
Clarification Statement	
Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids)	
Science and Engineering Practice:	Planning and carrying out investigations
Disciplinary Core Ideas:	The role of water in Earth's surface processes
The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks (HS.ESS2C.a)	
Crosscutting Concepts:	Structure and function
The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.	

EARTH'S SYSTEMS	HS-ESS2-6
LSSS	**NGSS**
Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.	
Clarification Statement	
Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.	
Science and Engineering Practice:	Developing and using models
Disciplinary Core Ideas:	Weather and climate
Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS.ESS2D.b) Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS.ESS2D.c)	
Crosscutting Concepts:	Energy and matter
The total amount of energy and matter in closed systems is conserved.	

HUMAN SUSTAINABILITY	HS-ESS3-1
LSSS	**NGSS**
Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.	
Clarification Statement	
Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth's other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms.	
Science and Engineering Practice:	Constructing explanations and designing solutions
Disciplinary Core Ideas:	Natural resources
Resource availability has guided the development of human society. (HS.ESS3A.a)	
	Natural hazards
Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations. (HS.ESS3B.a)	
Crosscutting Concepts:	Cause and effect
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	

<table>
<tr><th colspan="2">HUMAN SUSTAINABILITY   HS-ESS3-2</th></tr>
<tr><th>LSSS</th><th>NGSS</th></tr>
<tr><td colspan="2">Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.</td></tr>
<tr><th colspan="2">Clarification Statement</th></tr>
<tr><td colspan="2">Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural, soil use, forestry, and mining (coal, tar sands, and oil shales), and pumping (ground water, petroleum and natural gas). Science knowledge indicates what can happen in natural systems--not what should happen.</td></tr>
<tr><th colspan="2">Science and Engineering Practice:</th></tr>
<tr><td>Constructing explanations and designing solutions</td><td>Engaging in argument from evidence</td></tr>
<tr><th colspan="2">Disciplinary Core Ideas: Natural resources</th></tr>
<tr><td colspan="2">All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (HS.ESS3A.b)</td></tr>
<tr><th colspan="2">Designing solutions to engineering problems</th></tr>
<tr><td colspan="2">When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS.ETS1B.a)</td></tr>
<tr><th colspan="2">Crosscutting Concepts:</th></tr>
<tr><td>Systems and system models</td><td>Connections to engineering, technology, and applications of science</td></tr>
<tr><td>Systems can be designed to do specific tasks.</td><td>Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. Analysis of costs and benefits is a critical aspect of decisions about technology.</td></tr>
</table>

HUMAN SUSTAINABILITY	HS-ESS3-3
LSSS	**NGSS**
Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.	
Clarification Statement	
Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning.	
Science and Engineering Practice:	Using mathematics and computational thinking
Disciplinary Core Ideas:	Human impacts on Earth's systems
The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS.ESS3C.a)	
Crosscutting Concepts:	Stability and Change
Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.	

HUMAN SUSTAINABILITY	HS-ESS3-4
LSSS	**NGSS**
Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.	
Clarification Statement	
Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).	
Science and Engineering Practice:	Constructing explanations and designing solutions
Disciplinary Core Ideas:	Human impacts on Earth's systems
Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS.ESS3C.b)	
	Designing solutions to engineering problems
When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS.ETS1B.a)	
Crosscutting Concepts:	Stability and change
Feedback (negative or positive) can stabilize or destabilize a system.	

HUMAN SUSTAINABILITY	**HS-ESS3-6**
LSSS	**NGSS**
Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.	
Clarification Statement	
Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/ or biosphere. An example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations.	
Science and Engineering Practice:	Using mathematics and computational thinking
Disciplinary Core Ideas:	Weather and climate
Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. (HS.ESS2D.d)	
	Global climate change
Important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities (e.g., through computer simulations and other discoveries <u>satellite imagery</u>). (HS.ESS3D.b)	Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities.
Crosscutting Concepts:	Stability and change
Change and rates of change can be quantified and modeled over very short or long periods of time. Some system changes are irreversible.	

Underlined sections denote **additional information that appears in the Louisiana Student Standards for Science.*

<table>
<tr><th colspan="2">ECOSYSTEMS: INTERACTIONS, ENERGY AND DYNAMICS — HS-LS2-1</th></tr>
<tr><th>LSSS</th><th>NGSS</th></tr>
<tr><td>Use mathematical and/ or computational representations to support explanations of factors that affect carrying capacity, <u>biodiversity and populations</u> of ecosystems at different scales.</td><td>Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.</td></tr>
<tr><th colspan="2">Clarification Statement</th></tr>
<tr><td colspan="2">Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate and competition. Examples of mathematical comparisons could include graphs, charts, histograms, or population changes gathered from simulations or historical data sets.</td></tr>
<tr><th colspan="2">Science and Engineering Practice:</th></tr>
<tr><th colspan="2">Disciplinary Core Ideas:</th></tr>
<tr><td>Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges as predation, competition, and disease <u>that affect biodiversity, including genetic diversity within a population and species diversity within an ecosystem.</u> Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (HS.LS2A.a)

<u>Human activity directly and indirectly affect biodiversity and ecosystem health (e.g., habitat fragmentation, introduction of nonnative or invasive species, overharvesting, pollution and climate change).</u> (HS.LS2A.b)</td><td>Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.</td></tr>
<tr><th colspan="2">Crosscutting Concepts:</th></tr>
<tr><td colspan="2">The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.</td></tr>
</table>

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ECOSYSTEMS: INTERACTIONS, ENERGY AND DYNAMICS	HS-LS2-4
LSSS	**NGSS**
Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.	
Clarification Statement	
Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem.	
Science and Engineering Practice:	Using mathematical and computational thinking
Disciplinary Core Ideas:	Cycles of matter and energy transfer in ecosystems
Energy is inefficiently transferred from one trophic level to another that affect the relative number of organisms that can be supported at each trophic level and necessitates a constant input of energy from sunlight or inorganic compounds from the environment. (HS.LS2B.b) Photosynthesis, cellular respiration, decomposition and combustion are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, hydrosphere, and geosphere through chemical, physical, geological, and biological processes. (HS.LS2B.c) Photosynthesis, chemosynthesis, aerobic and anaerobic respiration and cellular respiration (including anaerobic processes) provide most of the energy for life processes. Environmental conditions restrict which and when reactions can occur. (HS.LS2B.a) (suggested extension)	Plants or algae from the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter is consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved.
Crosscutting Concepts:	Energy and matter
Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/ or fields, or between systems.	

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ECOSYSTEMS: INTERACTIONS, ENERGY AND DYNAMICS	HS-LS2-6
LSSS	**NGSS**
Evaluate the claims, evidence and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.	
Clarification Statement	
Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood and extreme changes, such as volcanic eruption or sea level rise. Emphasis should be on describing drivers of ecosystem stability and change, not on the organismal mechanisms of responses and interactions.	Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.
Science and Engineering Practice:	Engaging in argument from evidence
Disciplinary Core Ideas:	Ecosystem dynamics, functioning, and resilience
The dynamic interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability and may result in new ecosystems. (HS.LS2C.a)	A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.
Crosscutting Concepts:	Stability and change
Much of science deals with constructing explanations of how things change and how they remain stable.	

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ECOSYSTEMS: INTERACTIONS, ENERGY AND DYNAMICS	HS-LS2-7
LSSS	**NGSS**
Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.	
Clarification Statement	
Examples of human activities can include urbanization, building dams, or dissemination of invasive species.	
Science and Engineering Practice:	Constructing explanations and designing solutions
Disciplinary Core Ideas:	Ecosystem dynamics, functioning, and resilience
<u>Ecosystems with a greater biodiversity tend to have a greater resistance and resilience to change.</u> Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS.LS2C.b)	Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.
	Biodiversity and humans
Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). Humans depend on the living world for the resources and other benefits provided by biodiversity. Human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus, sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (HS.LS4D.a)	
	Developing possible solutions
When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. (HS.ETS1B.a)	
Crosscutting Concepts:	Stability and change
Much of science deals with constructing explanations of how things change and how they remain stable.	

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